SPECIES

# Diversity of Marine Sponges and their associated organisms in Fanar Ibn Hani Marine Protected Area (Latakia, Syria)

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**To Cite:**
Ammar IA, Ali AIK, Ibrahim KA. Diversity of Marine Sponges and their associated organisms in Fanar Ibn Hani Marine Protected Area (Latakia, Syria). *Species* 2023; 24: e82s1591
doi: https://doi.org/10.54905/disssi.v24i74.e82s1591

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**Peer-Review History**
Received: 03 August 2023
Reviewed & Revised: 07/August/2023 to 17/October/2023
Accepted: 21 October 2023
Published: 25 October 2023

**Peer-Review Model**
External peer-review was done through double-blind method.

Species
pISSN 2319–5746; eISSN 2319–5754



## ABSTRACT

Sponges and associated organisms had studied in Fanar Ibn Hani Marine Protected Area, northern of Latakia, during the period 2020-2022, Free diving and underwater photography were conducted at depths ranging from 2 to 10 meters on site. Analysing the photographs allowed us to identify fifteen species of sponges (two of Calcarea and thirteen of Demospongia). These species are: *Clathrina clathrus* (Schmidt, 1864), *Clathrina coriacea* (Montagu, 1814), *Chondrosia reniformis* (Nardo, 1847), *Spirastrella cunctatrix* Schmidt, 1868, *Axinella polypoides* (Schmidt, 1862), *Crambe crambe (*Schmidt, 1862), *Petrosia ficiformis* (Poiret, 1979), *Spongia officinalis (*Linnaeus, 1758), *Hippospongia communes* (Lamark, 1814), *Sarcotragus foetidus* Schmidt, 1862, *Sarcotragus spinusulus* Schmidt, 1862, *Ircinia strobilina* (Lamarck, 1816), *Aplysina insularis* (Duchassaing & Michelotti, 1864) and two different species of the genus Ircinia. Most of these species are nono-indigenous and recorded for the first time in the current study, polychaetes, red sponges, and bryozoans. Distinguished occurrence of alien sea slugs in the sponge's habitat.

**Keywords:** Demospongia, Eastern Mediterrenean, Marine biodiversity, Marine Protected Area, Natural stock, Non-Indigenous Species (NIS), Porifera, Sponges, Syrian coast.

## 1. INTRODUCTION

Marine sponges (phylum Porifera) are among the oldest animals to appear in the world's oceans. They are one of the best-documented phyla in the world (Pronzato, 2003; Pansini et al., 2011; Van-Soest et al., 2017). The World Porifera Database WPD, (2023) currently includes more than 8,500 species of sponges (Van -Soest et al., 2017; Gabriele et al., 2018). Scientists believe that there are more than 25,000 species has distributed in various depths and regions. Marine sponges represent an essential part of the biomass and diversity of benthic assemblages in many regions worldwide. In some areas, they form complex habitats known as sponge grounds, clusters, gardens, or reefs, especially in the deep sea (Xavier and Bo, 2017).

These habitats perform vital ecological roles such as serving as shelter and nursery, providing food for many other species of invertebrates and fish, regulating benthic settlement Maldonado et al., (2016), Pawlik et al., (2018), and also mediating energy transfer between benthic and pelagic systems and participation in biogeochemical cycles. Sponges are among the most primitive multicellular metazoa (Esposito et al., 2022). The body of a sponge consists of a mass of cells forming a porous structure made of organic components (collagen and, or sponge fibers, especially the demospongia) and inorganic components (spicules). Unlike most other animals, sponges lack actual tissues or organs. Instead, it has specialized cells that perform specific functions and a body organized around a canalicular system that filters water for food and oxygen.

One exception is the carnivorous sponges (family Cladorhizidae), which feed directly on small crustaceans. The spongy skeleton comprises of mineral (siliceous or calcareous spicules) and, or organic (spongein, collagen) elements, and some species lack the entire skeleton. The sponge's surface contains numerous small pores, through which water enters and exits. Sponge species consists of four orders: Hexactinellida, Demospongia, Calcarea, and Homoscleromorpha. Demospongiais the largest of these classes. It includes 85% of its species, i.e., more than 6,600 species. The number of sponge species in the Mediterranean Sea is about 700 species, except for the eastern part of the basin, which has not been extensively studied, compared to other Mediterranean regions (Idan et al., 2018; Voultsiadou et al., 2016; Topaloğlu and Evcen, 2014). Photophilous algae colonies the rocky reefs exposed to light.

These reefs had threatened by many of the synergistic human pressures represented by fishing, especially bottom dredging, pollution, and climate change. Lange, (2020), these challenges cause disturbance of benthic communities and ecosystem modification in many regions, and this has been demonstrated by the recording of alien species of Lessepsian origins Ammar and Fadel, (2017), Evcen et al., (2020) or from the Caribbean Sea (Bertolino et al., 2022). In addition to the recent decline in the abundance of commercial bath sponges that the region has witnessed due to their infection with diseases and the depletion of natural stocks (Çelik et al., 2011). The order Keratosa is the most common in the Levantine Basin, while the most common species based on the presence/absence of the species: *Chondrosia reniformis*, *Crambe crambe*, *Sarcotragus fasciculatus*, *Haliclona (Rhizoniera) sarai*, *Petrosia clavata*, *Phorbas fictitius, Sarcotragus spinosulus*.

The Syrian coast has many characteristics that make it suitable for sponge growth. Studies have shown that sponges fishing in Syria was thriving until the mid-seventies of the last century. For various reasons (intensive and unfair extraction, disease, pollution...etc.), the presence of these resources has become rare. The number of described species in Syria is 25 Ammar et al., (2008), Ammar and Fadel, (2017), Ammar, (2023), spread at depths ranging between 0.5 - 35 meters. The importance of the research comes from the extreme impact of climate changes in the region and global sea warming on marine biodiversity and the human pressures that the Syrian coast in general and the reserve site in particular has exposed to, in addition to the importance of sponges and their growing role, especially Demospongia, in tissue engineering and cosmetic markets.

**Research Aims**

The main objects of this research are to provide an updated spatial description of the sponges and their environment in rocky substrate in the shallow coastal area at the Fanar Ibn Hani MPA, detect the changes occurring in their diversity, identify the benthic species accompanying them, and evaluate the state of commercial sponges in order to culture and advantage it in the field of medical and pharmaceutical extracts.

## 2. MATERIALS & METHODS

**Study Area**

Sponges and some associated species have been photographed by Nouh Abbass at depths of 2-10 meters of Fanar Ibn Hani MPA (Figure 1), according to the coordinates (35.5927N, 35.74191E) (Google, 2023). Free diving work was carried out during the months of March, April, May, August, and November/2020, June and November/2021, January, May, July, and August/2022.

**Classify and Description of Sponges**

Species identification is based primarily on genetic structure, the skeleton's morphological analyses, and external characteristics. Many difficulties prevented the genetic analysis. Therefore, sponges were classified based on the reference descriptions contained in the World Porifera Database WPD, (2023) and Sealife Base (https://www.sealifebase.ca) as well as international references Hayward and Ryland, (2017), Bariche, (2012), Riedl, (2011), and was documented in cooperation with international experts in the field of sponges from the Hellenic Center for Marine Research (HCMR) and adopted the modern nomenclature contained in the Global Register of Introduced and Invasive Species (WoRMS, 2023).

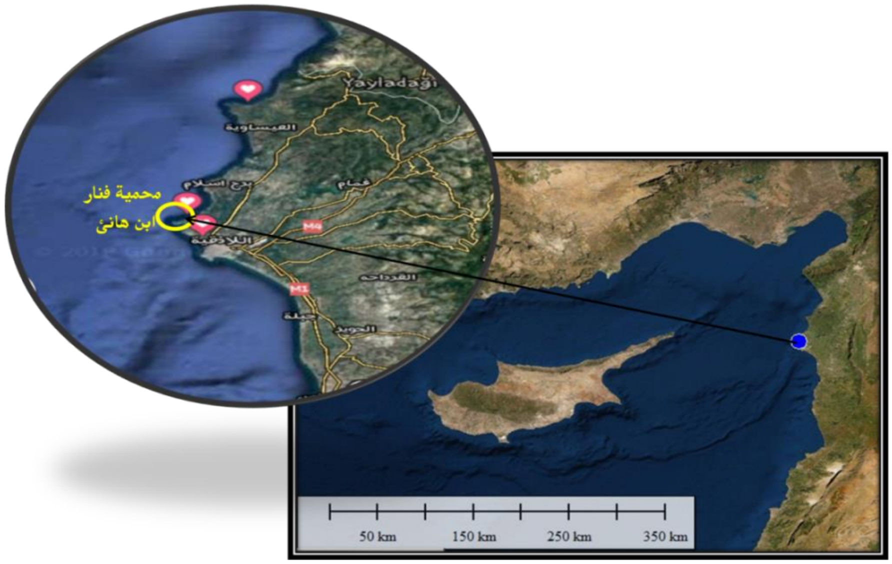



**Figure 1** Survey area at the Syrian coast (Google, 2023).

## 3. RESULTS & DISCUSSION

**Specific composition of sponges and associated organisms in the study area**

Description of the environment of sponges in shallow waters in the Fanar Ibn Hani MPA (Figure 2) includes the spatial description and specific composition of sponges and the associated benthic and sub-benthic organisms. Diving and photography are the approved method for characterizing benthic bio-assemblies and their structure in protected and sensitive areas and important environments such as coralligenous and calcareous bio-concretions (Pititto et al., 2014).

**Figure 2** A photograph of the sponge habitat and bottom in the Fanar Ibn Hani Reserve

The available study method, namely free diving and the nature of the substrate, has allowed recording the presence of a limited number of sponges, which did not exceed 15 species, from an area whose depth ranged between 2 and 10 m. These species belong to 11 genera, nine families, eight orders, and two classes: Demospongia and Calcarea. Table 1 shows a taxonomic list of these species and their origin (native or non-indigenous).

**Table 1** A taxonomic list of sponges and their origin in the study area

| Class | Order | Family | Species | Origin |
|---|---|---|---|---|
| Calcare | Clathrinida | Clathrinidae | Clathrina clathrus (Schmidt, 1864) | Native |
| | | | Clathrina coriacea (Montagu, 1814) | Native |
| Demospongia | Hadromerida | Chondorosidae | Chondrosia reniformis (Nardo, 1847) | Native |
| | Clionaida | Spirastrellidae | Spirastrella cunctatrix* (Schmidt, 1868) | Native |
| | Axinellida | Axinellida | Axinella polypoides (Schmidt, 1862) | Native |
| | Poicelosclerida | Myxillidae | Crambe crambe (Schmidt, 1862) | Native |
| | Haplosclerida | Petrosiidae | Petrosia ficiformis (Poiret, 1979) | Alien |
| | Dictyoceratida | Spongiidae | Spongia officinalis (Linnaeus, 1758) | Native |
| | | | Hippospongia communes (Lamark, 1814) | Native |
| | | Irciniidae | Sarcotragus foetidus (Schmidt, 1862) | Native |
| | | | Sarcotragus spinusulus (Schmidt, 1862) | Native |
| | | | Ircinia strobilina (Lamarck, 1816) | Alien |
| | | | Ircinia sp. | Alien |
| | | | Ircinia sp. | Alien |
| | | | Aplysina insularis | Alien |
| | Veronica | Aplysinidae | (Duchassaing & Michelotti, 1864) | Alien |

*The classification of the species has not been confirmed, as it closely resembles the red sponge Crambe crambe

The shown photographs are part of dozens of pictures taken at different degrees of zoom and angles of sessile species. The benthic assemblages in the study area consisted of sponges, anthozoans, algae, annelids, molluscs, ascidians, in addition to algae. The shapes of existing sponges varied between massive, encrusting, branching, and irregular sponges. It is worth noting that in some photos it was not possible to classify the species due to low resolution of the photos and changes in the color of the sponge, or the complexity of the shape, in correlation to the surrounding environmental conditions. Therefore, it is better to use more develop techniques, including isolating the spines, and determining the genetic structure. The most dominant species of sponges are *Sarcotragus foetidus*, *Chondrosia reniformis*, and *Crambe* crambe, which has spread everywhere. In addition, night diving is allowed for the documentation and photography of nocturnal species, especially crustaceans and cephalopods.

**Morphological and environmental characteristics of the sponge species**

***The calcareous sponge Clathrina clathrus (Schmidt, 1864)***

These yellow (or maybe white) sponge appear pillow-shaped from a distance, up to 10 cm in diameter (Clathrina coriacea is flatter in appearance), they can be seen from a distance and consists of a tangled mass of fibers that are thicker and less durable than those of C. coriacea (Figure 3a). This species is distributed in shallow waters in the Mediterranean and on the Atlantic coasts of Europe to the north of the British Isles. Individuals appear almost constantly on the rocky bottom above the red algae in the study area.

***Clathrina coriacea (Montagu, 1814)***

Calcareous sponge belongs to the Clathrinidae family. Its skeleton consists of calcium carbonate and contains spicules. It lives in shallow water on rocky documents and on other sponges. It had found along the Atlantic coast and even south Africa. This calcareous sponge plays an essential role in the environment by circulating food particles between the bottom and the water column. It feeds by filtering bacteria and other microorganisms. It is preyed on by species of shrimp and hermit crabs (Figure 3b).

***Chondrosia reniformis (Nardo, 1847)***

Block sponge, with a soft, smooth surface, covered with a thin outer layer supported by collagen fibers, (Figure 3c). This species had described in the Mediterranean Sea, the Adriatic Sea, South Africa, Cape Verde, South India and Sri Lanka, Arabian Sea, South European Atlantic Shelf and the North Atlantic Ocean (WoRMS, 2023). It was previously collected and described from several locations on the Syrian coast from depths ranging between 5 and 15 meters (Ammar et al., 2008; Fadel, 2018). In the study area, it lives on hard bottoms at 2-10 meters deep. It is considered a producer of collagen, especially used in cosmetics and biomedical preparations. Many researches have been conducted to culture it to extract collagen from it (Gökalp et al., 2020).

***Axinella polypoides (Schmidt, 1862)***

Erect, branched sponges, extending several centimeters, orange-yellow in colour, (Figure 3d). This species had observed in Al-Basit and Ibn Hani (Ammar et al., 2008, Fadel, 2018). It lives on hard bottom in the study area, at a depth of 10 meters. This species and other Axinella species constitute a real resource of bioactive compounds (Esposito et al., 2022).

***Crambe crambe (Schmidt, 1862)***

It is called the red-orange sponge. It grows in the form of a crust, forming extensions and an irregular cover on the solid bottom (Figure 3e). It had described in Ibn Hani, Baniyas, Al-Basit, and Tartous (Ammar et al., 2008, Fadel, 2018). This species is common in the Mediterranean, southwestern Europe and the Adriatic Sea, and has also been recorded in the Atlantic Ocean WoRMS, (2023), almost dominating the hard bottoms in the shallow inshore zone. It is very important to note that the Spirastrella cunctatrix species is very similar to the Crambe crambe species, and both of them can live in a shaded environment, and therefore confusion between them is possible. This type is a new therapeutic source for extracting anti-cancer substances to eliminate pancreatic tumors (Padiglia et al., 2018)

***The stony sponge Petrosia ficiformis (Poiret, 1979)***

It is a rocky marine sponge of the order Haplosclerida. It is the first record in Syria through this research. This species lives on the underside of rocks, outcrops, and in caves extending from the surface to several meters deep. This species had described in the Levantine Basin, Adriatic Sea, Aegean Sea, Eastern Mediterranean Basin, North Atlantic Ocean, Tunisian Plateau/Gulf of Sidra, West Africa, and Western Mediterranean (WoRMS, 2023). *P. ficiformis* is usually colored purplish-brown due to symbiosis with photosynthetic cyanobacteria, but can become white in the absence of light. Its texture is hard and compressed, oscula are spread irregularly on the surface (Figure 3f).

It sometimes grows branched and its color is damaged in semi-dark conditions, as in (Figure 3g). *P. ficiformis* is one of the sponges that produces a large amount of acetylene, isolated for various purposes in industry. It manufactures Petroformynes, a type of hydroxylated polyacetylene with cytotoxic and antitumor activities (Ferretti, 2007). It is the primary and favorite food of sea snails, which explains the presence of many of them in the study area, as these mollusks collect chemical compounds found in sponges in their digestive tube and use them as a means of defense.

***Spongia officinalis (Linnaeus, 1758)***

An essential and expensive species, it is an excellent bath sponge, spread mainly on the coasts of Greece and has also been found throughout the Mediterranean (WoRMS, 2023; Voultsiadou et al., 2016). This species has many shapes, and individuals of *S. officinalis* often grow in global growths or large masses. It lives in the study area at a depth of 10 meters.

***Hippospongia communes (Lamark, 1814)***

The most common sponge in the Mediterranean Sea. It is widespread in the Adriatic Sea, North Atlantic Ocean, and the Red Sea. Previous research accurately described this species (Ammar et al., 2008; Fadel, 2018). It lives on rocky bottoms (Riedl, 2011). H. communes is used for cosmetic and household purposes (as a bath sponge) and in some pharmaceutical industries to extract antibiotics Zdarta et al., (2016) and dyes Norman et al., (2016); its presence was previously observed in all studied sites. It lives in the study area at a depth of 5 meters.

***Dark stinging sponge Sarcotragus foetidus Schmidt, 1862***

This species had described for the first time in Syria. It is a large sponge; its natural shape is global, its diameter can reach 50 cm. Its height is 15 cm. The surface is irregular and folded, with small conical projections 1.5 -3 mm high and placed 10 - 15 mm apart (Figure 3h). The main structure consists of a net of primary and secondary fibers (about 50-100 μm in diameter (November 2012, 2023), the color is varied from grey-pink, its surface may be covered with various organisms. This sponge is very similar to *Sarcotragus spinosulus*, showing smaller terminal bristles. It also resembles *Scalarispongia scalaris* but is more durable. Although its external appearance resembles a typical bath sponge, it cannot be cleaned and used as a bath sponge. It is distributed in Morocco, the North Atlantic Ocean, the western Mediterranean Sea, the Eastern Basin, the Adriatic Sea, the Aegean Sea, and the Ionian Sea (Pavloudi et al., 2016; Krikech et al., 2020; De-Voogd et al., 2023).

***Sarcotragus spinosulus* (Schmidt, 1862)**

Its growth is regular and massive; its diameter rarely exceeds 10 cm. It is black or dark gray in vivo (Figure 3i). Its texture is strong and somewhat flexible. The oscules diameter reaches 1cm and is scattered irregularly. The skeleton is a net of primary fibers (90-180 µm in diameter) and secondary fibers (50-100 µm). With abundant bristles (0.7-2.0 µm in diameter), which gives a solid bond for the sponge structure. *S. spinosulus* lives in caves, rocky bottoms, and coralligenous assemblages at depths ranging from 11 - 60 meters. (Gerovasileiou and Voultsiadou, 2012). This sponge is widespread in the eastern and northern Atlantic Ocean, the southern shores of Europe on the Mediterranean Sea, Tunisia, the Aegean Sea, the Adriatic Sea, Greece, and the Levantine Sea (WoRMS, 2023). It is the first record of this species in Syria.

***Ircinia strobilina* (Lamarck, 1816)**

A large sponge, black-gray in color, with a rough surface, equipped with large, widely spaced holes. The structure had covered with a thick surface layer of sediments (Figure 3i). Its skeleton comprises of an irregular network of spongy fibers surrounded by sand. The sponge filaments are thin as well as conductive fibers Fadel, (2018), and it has no Thorns. This species has an unpleasant odor when taken out of the water. Its individuals are resistant to predation. Compounds extracted from the genus Ircinia have a wide range of antibacterial, anti-inflammatory, and antitumor activity (Gomes et al., 2016). This species is widespread in Brazil, Venezuela, Caribbean Sea and North Atlantic Ocean (WoRMS, 2023). Its presence was previously recorded in the Ibn Hani, Baniyas, Tartous, and Al-Basit (Ammar et al., 2008; Fadel, 2018).

***Ircinia variabilis* (Schmidt, 1862)**

Sponge-shaped growths, reaching 20-25 cm in height and diameter. Its color changes and ranges from light or dark gray to light or dark brown and light or dark violet. Its texture is flexible and durable. The dimensions and density of holes are variable and have no particular characteristic. The expiratory nostrils are scattered. The structure consists of protofibers (150–250 µm in diameter) etched with opaque foreign materials that support the cells at their apices. The secondary fibers are primarily free of impurities, and their diameter varies between 10-200 µm.

I. variabilis lives in caves, collagenous assemblages, rocky bottoms, and coastal abysses at depths ranging from 0-450 m. Figure (3j) is a purple sponge *Ircinia variabilis* and the red sponge *Crambe crambe* or *Spirastrella cunctatrix* (Schmidt, 1868). The great similarity between them requires more precise analysis. It has distributed in the Aegean Sea, the Adriatic Sea, the Black Sea, the eastern Mediterranean Sea, its western basin, and the North Atlantic Ocean (WoRMS, 2023). It is the first time this species had documented on Syrian coast at the Ibn Hani site, at a depth of one meter.

***Ircinia sp***

A form of Ircinia - Nardo, 1833, Large, blocky sponge whose morphological characteristics all match the species Ircinia laeviconulosa sp. nov. It is a Caribbean species recently discovered in Panama (Kelly et al., 2020). This species lives within coral spots in shallow depths, and its name refers to its smooth surface. The common shape of the body is global and its color is dark green to pink. Its external surface is smooth, and the cones are low in height. The exhalation openings are scattered and flat, not exceeding 1 cm in diameter (Figure 3k). The presence of sponge threads and the pungent smell of sulfur confirm that it is Ircinia, and the fibers do not contain impurities like other species of this genus. It grows next to the black sponge I. strobilina (Lamarck, 1816), and they have easily distinguished by the large conules of *I. strobilina.*

***Ircinia sp.***

Another specimen belonging to the Ircinia was found and photographed at the MPA. Defining the species requires genetic analysis and advanced techniques. The species appears irregular in shape and has a durable structure. The osculums are clear, and the osculas are cones that end in wide openings. The color is orange-reddish brown, (Figure 3l).

***The yellow sponge Aplysina insularis* (Duchassaing & Michelotti, 1864)**

It lives on rocky bottom in the shallow coastal areas and deep sea. Its shape is tubular in general, and its natural color in the water is yellow. Its color changes when taken out of the sea. *Aplysina insularis* is a giant sponge that consists of one or more cylindrical branches, uniting at the base, each one narrowing and terminating at the apex into a large osculum, which can be surrounded by small finger-like bubbles. Thin tendrils and more significant rope-like bubbles, may also appear, and in areas with high levels of

sedimentation, these tubes may increase in size. This sponge can grow to a length of 50cm, tube diameter of 8cm, and feels soft yet sturdy. The external surface is either smooth or covered with fine conical projections (Figure 3m).

There are no siliceous spicules in the wall. Still, it has reinforced with a net of fibers that form a hexagonal, circular, or circular netting. The color is yellowish-brown and changes in deep water to greenish yellow. The presence of another species, *A. aerophoba*, was previously recorded in several locations on the Syrian coast (Ammar et al., 2008). *Aplysinainsularis* in (Figure 3m) is in bad condition, as fungal growths had observed. *Aplysina insularis* occurs in the Caribbean Sea, Gulf of Mexico, Bermuda, Florida, and Brazilian economic water (WoRMS, 2023). It is found at depths up to 40 meters. On coral reefs, especially on the outer edges of rocky shelves (Species-identification.org, 2016).

It is the first recording of this species in the Mediterranean Sea and Syria, according to maps of its distribution in the global databases (World Porifera database), and this in itself isa significant international addition. Its occurrence can be explained by maritime transport operations that contributed significantly to transporting warm tropical species over long distances and their arrival in environments witnessing an increase in temperature due to warming seas, especially in the eastern Mediterranean (Costa et al., 2019). Additional species had photographed and not classified. The following (Figure 3n) is an unidentified species of branching sponge whose classification requires genetic analysis.

In general, the bottom of the reserve area was dominated during the study period by red algae, serpulids, bryozoans, and crambe crambe, as is evident in (Figure 4). The number of available sponges on the Syrian coast seems small compared to the number discovered up to the year 2020 in the Levantine Basin, which amounted to 89 species and 250 species in the Aegean Sea, according to World Porifera Database (WPD, 2023). In neighboring countries, such as Turkey, the number of species reached 51 on the Mediterranean coast and 82 on the Aegean (Topaloğlu and Evcen, 2014). Thirty-two species were identified in shallow waters in Cyprus Bertolino et al., (2022), 215 species in Greece Voultsiadou et al., (2016), and 329 species had identified in sea caves in southern Italy (Longo et al., 2023). It reflects the impact of overfishing, pollution, environmental conditions, climate disturbances, water warming Costa et al., (2019), and the destruction of benthic habitats on the diversity and abundance of sponges. It has known that overfishing reduces the immunity of sponges and reduces their defensive ability against unfavorable environmental conditions (Pronzato et al., 2014).

On the other hand, recording extra alien sponges on the Syrian and Mediterranean coasts provides an essential scientific and environmental addition at the level of the Mediterranean Sea, and it requires monitoring their spread in other regions. Mode of introduction of these species in the area is unknown, and it has expected that they had transmitted via Ships (ballast water and fouling). The Ircinidae family is represented by the most significant number of species, amounting to (5) species; the family Axinellidae had characterized by *Axinella polypoides* where the presence of the *Chondrosia reniformis* and the species Chondrosia corticata had recorded. Sampling operations showed the semi-permanent presence of three species of sponges: *Spongia officinalis*, *Ircinia strobilina*, and *Axinella polypoides*, with a significant dominance of *Sarcotragus foetidus* at the depths studied during the period 2020-2021.

The abundant presence of the black sponge, *Sarcotragus foetidus* (Schmidt, 1862), at the site of Ibn Hani, in the form of small balls is an excellent scientific addition and an additional record of the spread of this species in the Mediterranean Sea, according to its global distribution map. The continued emergence of *Spongia officinalis* and *Hippospongia communes*, the most important species (despite the many environmental challenges), confirms the suitability of the Syrian marine environment for the spread of these species, for which they have long been famous. A fast assessment of the species observed in the area shows the contribution of the geomorphology of the bottom, the presence of rocky outcrops, and the vertical slope of the rocky edge at the reserve site to the quality of the benthic communities that live on. The results confirm the critical role of amateur divers and those interested in marine biodiversity from outside the research and academic community in adding more information in this regard and noting that diving work accompanied by underwater photography and analysis of photographs is a modern method followed, especially in MPAs (Canessa et al., 2021).

All of the above allowed documenting the existence of additional species of sponges that had not mentioned in any research work. On the other hand, comparing the results of this study with the results of previous researches shows the absence of many species in the same place, this may be explained by the potential impact of rising water temperatures in the eastern Mediterranean on sponge diversity (Zittis et al., 2022). The effect of overfishing and illegal fishing in the area (even within the reserve) on the diversity and quantity of sponges in the studied site synergizes with sponge diseases, as overfishing reduces the immunity of sponges and reduces their defensive ability against unfavorable environmental factors (environmental transgressions) (Pronzato et al., 2014). This had observed for some species that appeared in lousy condition.

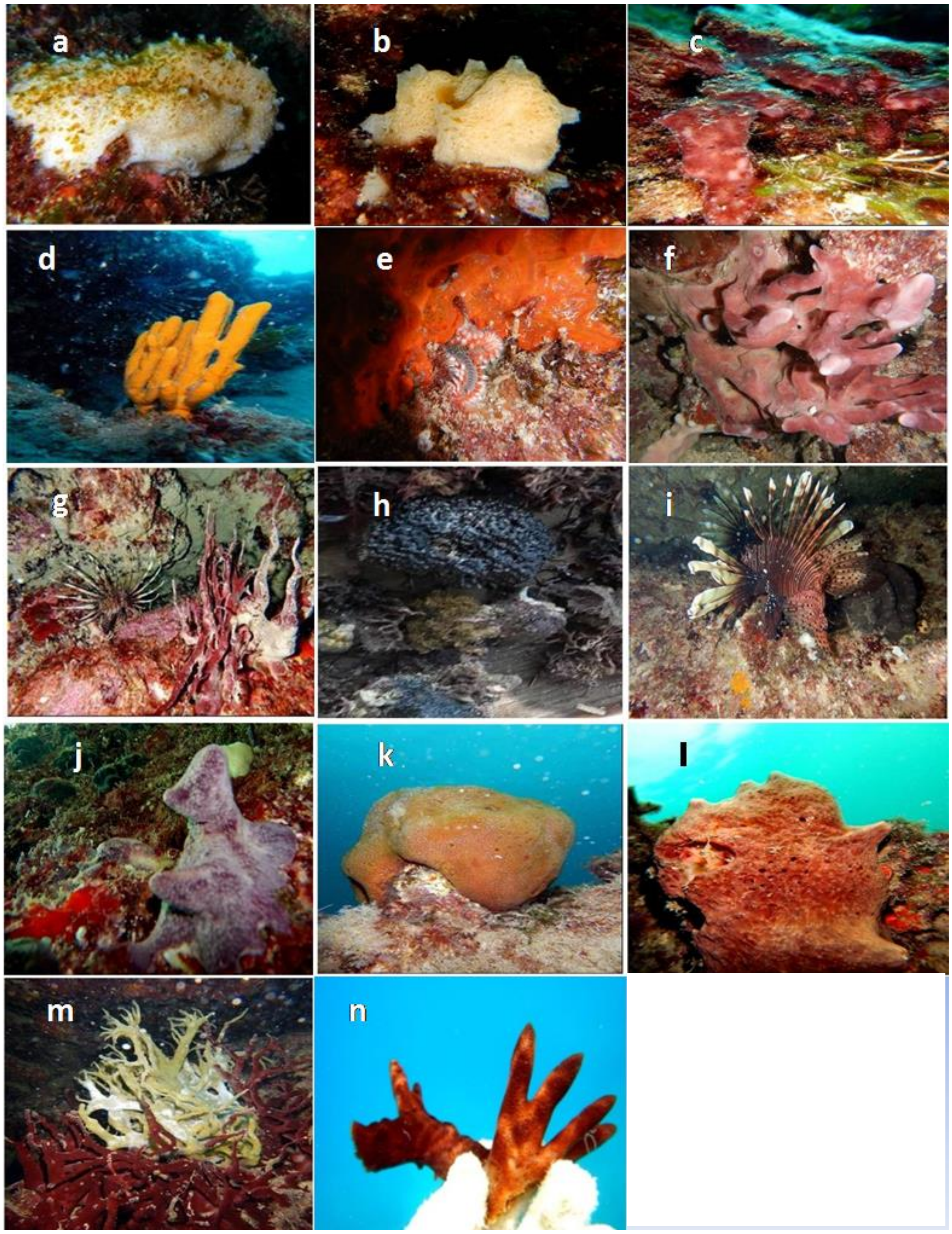



**Figure 3** Underwater photographs of: (a) *Clathrina clathrus*, (b) *Clathrina coriacea*, (c) *Chondrosia reniformis,* (d) *Axinella polypoides*, (e) *Crambe crambe*, (f & g) *Petrosia ficiformis*, (h) *Sarcotragus foetidus,* (i) *Sarcotragus spinusulus*, (j) *Ircinia variabilis* & *Crambe crambe*, (k) Ircinia sp., (l) Ircinia sp., (m) *Aplysina insularis* (purple) and (n) *Petrosia ficiformis* (yellow) (at 2-10 m, off Ibn Hani MPA, Latakia coast, Syria).

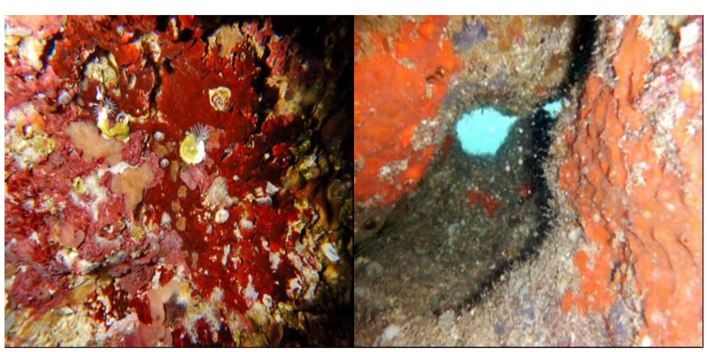


**Figure 4** The bottom of the study area had dominated by red algae, crustacean sponges, and Bryozoans

**Associated organisms with sponges in the study area**

Diving operations allowed observing many macroorganisms in the habitat of the sponge, in particular crustaceans such as *Penaeus japonicus* (Spence Bate, 1888), the Mediterranean lobster *Scyllarides latus* (Latreille, 1803), blue crab *Portunus segnis* (Forskål, 1775) and Rosy egg crab *Atergatis roseus* (Rüppell, 1830). The presence of many species of gastropod mollusks had documented also, such as the giant *Tonna galea* (Linnaeus, 1758), which is one of the species recommended for international protection, in addition to eight species of aliensea slugs, *Goniobranchus obsoletus* (Rüppell & Leuckart, 1830), *Goniobranchus annulatus* (Eliot, 1904), *Aplysia dactylomela* (Rang, 1828), *Hypselodoris infucata* (Rüppell & Leuckart, 1830), *Elysia grandifolia* (Kelaart, 1858), *Bursatella stellata* (Risso, 1826), *Plocamopherus ocellatus* Rüppell and (Leuckart, 1828), *Tayuva lilacina* (A. Gould, 1852), in additionto the common octopus *Octopus vulgaris* (Cuvier, 1797), and the two squids: *Sepia officinales* (Linnaeus, 1758) and the alien *Sepioteuthis lessoniana* d'Orbigny, 1826. In (Figure 5); there are photos of 8 species of sea slugs; their sizes ranged between 2 cm for *Bursatella stellata* and 8 cm for the invasive species *Aplysia dactylomela.*

Additional species had found on rock substrate at the site (Figure 6), they are two species of Anthozoa: *Actinia mediterranea* (Schmidt, 1971), and the alien coral, *Oculina patagonica* de Angelis D'Ossat, 1908, which had recorded for the first time in Syria through this study; it is one of the alien species Çinar, (2006), it is originis the southwestern Atlantic Ocean and may have reached the Mediterranean by sea transport. The rare red comb star *Astropecten aranciacus* (Linnaeus, 1758), and large numbers of the black sea urchin, *Diadema setosum* (Leske, 1778) had observed. The species *Spirobranchus tetraceros* (Schmarda, 1861), an invasive polychaete, has also been observed to be abundant. A previously unrecorded alien species of Bryozoan was also found (under publication). Species of exotic fish, such as lionfish *Pterois miles* (Bennett, 1828), *Dicentrarchus labrax*, and the brown moray, were also observed permanently at the sponge ground, in addition to noting turtles, jellyfish and algae.

The divers results obtained could be linked to many variables, including overfishing, pollution, and climate change, was represented by an increase in the annual average of both water temperature and salinity. The surface sea water temperature ranged between 17-31 °C, with an average of 23.1 °C during the year 2022 (Figure 7). The salinity also ranged between 37.3 - 38.8‰, with an average of 38.08. Recent local readings of average temperatures on the Syrian coast are consistent with values in the eastern Mediterranean Sea (Pisano et al., 2020).


**Figure 5** Underwater photographs of associated sea slugs in the sponges habitat of the survey area: (a) *Goniobranchus obsoletus,* (b) *Goniobranchusannulatus*, (c) *Aplysia dactylomela*, (d) *Hypselodoris infucata*, (e) *Elysia grandifolia.* (f) *Bursatella stellata*, (g) *Plocamopherus ocellatus,* (h) *Tayuva lilacina.* There is no specific scale for photographs, as the size of the object in the image varies depending on its proximity or distance, as well as the degree of zoom.

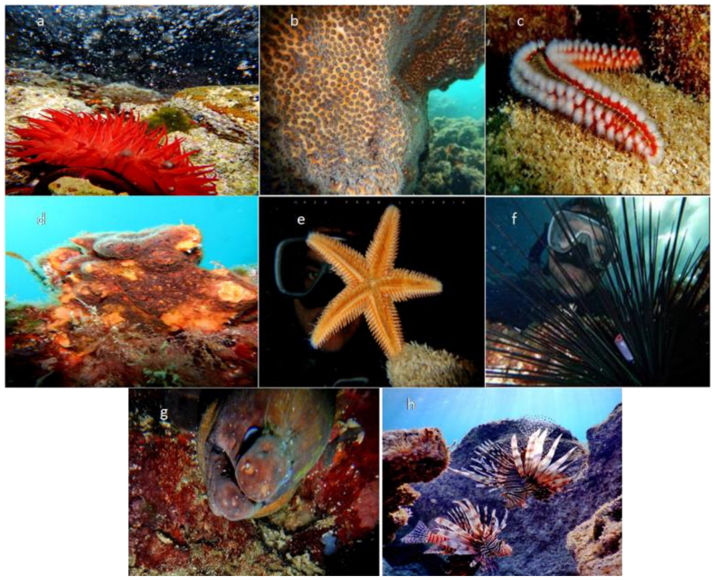
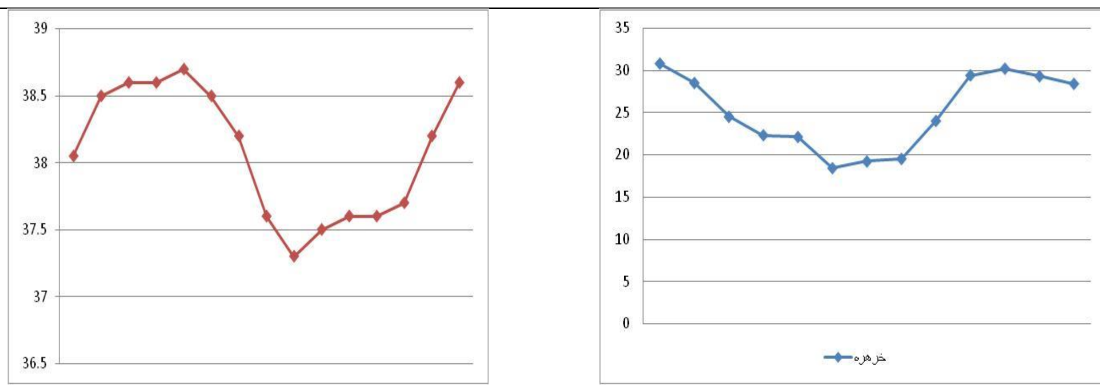



**Figure 6** Underwater photographs of another associated sea life in the sponges habitat of the survey area: (a) *Actinia mediterranea*, (b) *Oculina patagonica*, (c) *Spirobranchus tetraceros,* (d) Bryozoan, (e) *Astropecten aranciacus*, (f) *Diadema setosum,* (g)-Sea snke, (h) *Pterois miles*




Changes of Salinity (‰) during 2022 Changes of Temperature (°C) during 2022

**Figure 7** Changes in surface water temperature and salinity on the Syrian coast during 2022.

## 4. CONCLUSIONS

The diversity of sponges is limited in the study area, the effect of overfishing seems clear, and the terrible conditions of some species and fungal infections was clear. However, most of these species have environmental, economic, and pharmaceutical value. The fieldwork method allowed to detection more species of sponges, corals, and Bryozoans, some of non-indigenous species was recorded for the first time in Syria and the eastern Mediterranean. Accordingly, it is recommended to establish small farms for sponges with the aim to produce anti-cancer compounds, collagen, and other bioactive materials. Implementing laws and spreading awareness about the importance of sponges has become necessary. Organizing cooperative relationships between scientific communities, amateurs, and non-academic divers because of their important role in providing additional data that traditional research methods cannot access.

**Acknowledgment**

The authors would like to thank all of the administration of Tishreen University, which funded the research, the diver Noah Abbas for his efforts and beautiful pictures, Dr Vassilis Gerovassiliou for his help in classifying the sponges and Dr Argyro Zenetos for her support.

**Author Contributions**

Have made substantial contributions to conception and design, acquisition of data, and analysis and interpretation of data.
Have given final approval of the version to be published.
In fieldwork, collect, and analyze data.

**Conflicts of interests**

The authors declare that there are no conflicts of interests.

**Ethical approval**

The ethical guidelines are followed in the study for species observation & identification.

**Funding**

This study was funded by Tishreen University.

**Data and materials availability**

All data associated with this study are present in the paper.

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